Rowow LLC, NSF PESOSE Track 1 proposal 2640754, summary and description (public copy, pending)

> **Status, November 2026.** This proposal was submitted to NSF on August 21, 2026 and is pending NSF review as of November 2026. No award has been made. The text below is the Project Summary and Project Description as submitted, with References Cited, shortened for public release. Where text was removed, the mark section shortened appears. Statements about current and pending support describe the situation in August 2026. Since then, the NSF SBIR Phase I proposal 2638268 was declined on November 3, 2026, and the DLA SBIR and DOE NETL applications were also declined in 2026. Budget documents, personnel documents and letters are not included in this copy. Bracketed notes dated November 2026 mark claims as submitted that are not presented here as verified current results.

Project Summary

Overview

Ion-exchange membranes enable electrodialysis, electrochemical metal recovery, redox flow batteries, and water treatment, but incumbent perfluorinated membranes cost hundreds of dollars per square foot and come from a concentrated foreign supplier base, keeping membrane electrochemistry out of reach of small laboratories, educators, startups, and domestic critical-minerals processors. Note, November 2026: claim as submitted in August 2026. Not a verified current result. Rowow LLC publishes an open-source alternative: a homogeneous ion-exchange membrane fabricated from off-the-shelf precursors for under $1 per square foot, released under CERN-OHL-S v2 with a patent license and public non-assertion pledge. Note, November 2026: claim as submitted in August 2026. Not a verified current result. section shortened What the product lacks is an ecosystem: a managing organization, community governance, a quality-control program for community-fabricated membranes, a supply-chain provenance standard, and a sustainability model independent of the founding company. This Track 1 project scopes exactly that: the team completes I-Corps for PESOSE with at least 100 ecosystem-discovery interviews across flow-battery, water-treatment, metal-recovery, and education segments, designs the managing organization and contribution pipeline, produces a risk analysis and security plan centered on tested-build certification and traceable bills of materials, and delivers a community growth plan with named maintainer candidates and a seated advisory group. The award funds ecosystem formation only; no membrane or cell research and development is proposed.

Intellectual Merit

The project develops a transferable model for securing open-source hardware ecosystems where the product is physical, hazardous, and safety-critical, a setting where software-derived open-source security practice does not directly apply. Deliverables include a low-cost community-executable QC

protocol validated by round-robin inter-laboratory comparison, a bill-of-materials provenance standard adapting software supply-chain guidance to physical precursors, community-governed staged-disclosure safety gates, and governance structures that keep a strongly reciprocal license and patent pledge durable beyond any single firm.

Broader Impacts

Low-cost membranes are an enabling input for domestic critical-minerals recovery, a stated national priority, and an open ecosystem lets any qualified domestic fabricator produce the component without royalty or lock-in. Sub-dollar membranes put practical electrochemistry within reach of small laboratories, community colleges, and startups. Note, November 2026: claim as submitted in August 2026. Not a verified current result. Workshops, educator-contributed curricula, and a community build-and-test event train hands-on electrochemistry and measurement skills, and the certification framework raises the safety floor for a public already building this hardware. The project supports PESOSE measures of success: new research infrastructure, expanded data sets, and STEM workforce development.

Keywords: critical minerals; open-source hardware; ion-exchange membrane; electrochemistry; supply chain security

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Project Description

1. The open-source product and its current status

The open-source product is a low-cost homogeneous ion-exchange membrane: the design, the manufacturing process, and the documentation needed to fabricate it from off-the-shelf precursors (pulverized commercial ion-exchange resin dispersed in a PVC/CPVC matrix) for under $1 per square foot of working area. Note, November 2026: claim as submitted in August 2026. Not a verified current result. Conventional perfluorinated membranes serving the same functions cost hundreds of dollars per square foot. Note, November 2026: claim as submitted in August 2026. Not a verified current result. The product is published in a public repository maintained by Rowow LLC [1], with video build guides [2], a documentation site [3], and an active community chat server.

Licensing. The hardware design source is licensed under CERN-OHL-S v2, a strongly reciprocal open hardware license; written documentation is licensed CC BY-SA 4.0. The membrane and its manufacturing process are the subject of US non-provisional patent application No. 19/531,984 (filed February 6, 2026, inventor Robert Karas). The CERN-OHL-S v2 release carries a patent license for the covered design under section 7.1 of that license, and the application is the first entry on Rowow's public Pledged Patents list under a published draft Patent Non-Assertion Pledge [4]. Wording corrected November 2026: "draft" added. The Open Technology Charter and Patent Non-Assertion Pledge are published as public drafts for comment and have not been adopted, so the patent applications are proposed for the pledge, not yet pledged. The base recipe was first published in February 2026 under a CC0 1.0 dedication, superseded in June 2026 by the CERN-OHL-S v2 release so that derivative designs remain open.

Current status, dissemination, users, and contributors (verified August 2026):

- Repository: 134 stars, 38 forks, 19 watchers, and roughly 58 commits since the initial release on February 6, 2026 [1].

section shortened

- Testing model and contributor pipeline. The repository includes a community characterization data file with a measurement protocol, a structured Build Report issue template, a public replication log that records failed builds as first-class evidence, and a CONTRIBUTING policy accepting design and data under CERN-OHL-S v2 and documentation under CC BY-SA 4.0 [1]. Note, November 2026: claim as submitted in August 2026. Not a verified current result.
- Users in the field: flow-battery experimenters and researchers, water-treatment and metal-recovery practitioners, electrochemistry educators, and small laboratories that could not previously afford membrane-based electrochemistry.

What does not yet exist, and what this Track 1 award scopes: a managing organization, a formal governance model, a quality-control and build-verification program for community-fabricated membranes, a security and provenance framework for the hardware supply chain, and a sustainability model that does not depend on one company or one person.

2. The problem being addressed

Ion-exchange membranes are the enabling component of a wide class of electrochemical processes: electrodialysis, electrolysis for metal recovery and acid regeneration, redox flow batteries, fuel cells, and water treatment. Membrane cost has kept these processes out of reach of small laboratories, educators, startups, and domestic processors: incumbent perfluorinated membranes cost hundreds of dollars per square foot, come from a small number of foreign-concentrated suppliers, and carry PFAS-related environmental exposure. Note, November 2026: claim as submitted in August 2026. Not a verified current result. The open-source membrane removes the cost barrier and the single-vendor lock-in. National relevance is direct: membrane electrolysis is a route to domestic recovery and refining of critical minerals from ores, tailings, and waste streams, an area where the United States depends on foreign processing capacity. section shortened

The problem this OSE addresses is not membrane R&D. The membrane exists, is published, and has been independently replicated and verified. Note, November 2026: claim as submitted in August 2026. Not a verified current result. The problem is that a fast-growing user community is fabricating electrochemical hardware from open designs with no managing organization behind the product: no formal governance for accepting and releasing design changes, no quality-control program that tells a user whether a community-made membrane is safe and fit for purpose, no provenance standard for the materials going into builds, and no sustainability plan beyond the founding company. Community-fabricated electrochemical hardware carries real safety stakes (solvent handling, fine resin dust, and cells that can evolve chlorine and hydrogen), so the gap between adoption and governance is a security and safety problem in the PESOSE sense, not only an organizational one.

3. Long-term vision and potential impact

The long-term vision is a self-sustaining open-source ecosystem in which the membrane and its downstream cell and stack designs are governed by a managing organization independent of any single firm; community-fabricated membranes can earn a tested-build certification against a published QC protocol; every released design carries a traceable bill of materials with vetted domestic sourcing options; and contributor and user communities in flow batteries, water treatment, metal recovery, and education carry development forward. Rowow's published Open Technology Charter, Staged Disclosure Policy, Patent Non-Assertion Pledge, and Vetted Partner Framework [4] already state the governance intent: impact over ownership, an open core with commercial applications funding the commons, and safety documentation gates ahead of hazardous step-by-step releases. Note, November 2026: claim as submitted in August 2026. Not a verified current result. This award converts founder-authored doctrine into a community-governed structure. Success in ten years looks like a standards-setting body for low-cost ion-exchange membranes, a distributed base of qualified fabricators, and US small labs and manufacturers using electrochemical separation as routinely as they use 3D printing today.

4. Scoping activities

Track 1 awards support planning, not product development. No membrane or cell R&D is proposed.

4.1 Ecosystem discovery

The team will execute the mandatory I-Corps for PESOSE curriculum with a team of three and complete at least 100 ecosystem-discovery interviews across the four candidate user segments: flow-battery developers and researchers, water-treatment operators and engineers, metal-recovery and e-waste processors, and educators. section shortened In parallel the team will map the current user base empirically (repository analytics, structured surveys of chat-server and build-report participants, interviews with the independent replicators) and document why an OSE, rather than a commercial product line alone, is the right structure. Deliverable: an ecosystem-discovery report identifying the highest-value user segments, the conversion path from user to contributor for each, and demand evidence for a tested-build certification.

4.2 Organization and governance

The team will evaluate candidate structures for the managing organization (fiscal sponsorship under an established open-source foundation, a standalone nonprofit, or a consortium) against cost, neutrality, and continuity criteria, producing a recommendation with a formation plan and draft governing documents prepared with counsel. It will formalize the contribution pipeline: maintainer roles beyond the founder, a technical steering process for accepting design changes, a documented release process with versioned design freezes, and a contributor license agreement consistent with the dual-license structure. Licensing governance will be codified so the CERN-OHL-S v2 license, the section 7.1 patent grant of application No. 19/531,984, and the Patent Non-Assertion Pledge survive any change in Rowow's status, including the charter's default-to-open continuity mechanism (a named steward and a standing release instruction). Metrics for long-term success will be defined: contributor

counts and retention, verified replications, certified builds, data-file growth, downstream design adoptions, and organizational independence milestones. Deliverable: a governance design package ready to execute under a Track 2 award.

4.3 Risk analysis and security plan

Open-source hardware for electrochemistry has a threat model that differs from software but is just as concrete. The scoping work treats four risk classes.

Quality and safety of community-fabricated hardware. A membrane that fails in service can release chlorine into a workspace or destroy a cell. The team will scope a build-verification and QC program: a published test protocol (ion-exchange capacity, resistance, selectivity, and durability) executable with low-cost equipment, and a tested-build certification with defined evidence standards, building on the existing replication log and characterization data file [1, 5]. As a scoping activity, the draft protocol will be tested for executability through a small round-robin comparison with independent volunteer laboratories, developing and validating the community's methods of verification ahead of full program execution under a future Track 2 effort. section shortened No membrane development is involved; the round-robin measures existing community-fabricated samples solely to validate the measurement protocol itself.

Supply-chain provenance of materials. Resin, matrix polymer, and solvent quality determine membrane behavior and user safety. The team will scope a traceable bill-of-materials standard for every released design: specified acceptable precursor classes, known-good domestic sources, substitution rules, and provenance fields in build reports, adapting the intent of software bill-of-materials practice to physical materials. CISA and NSA supply-chain guidance for developers and the OpenSSF Best Practices criteria [7, 8] will be mapped to open hardware equivalents, and the repository will pursue the OpenSSF best-practices badge where criteria apply.

Integrity of the design source and data. The team will scope and implement repository security controls: maintainer identity management, signed releases, protected branches, two-person review for design changes, an enforced append-only policy for the characterization data file, and chain of custody from build report to verified log entry.

Safety of disclosure itself. Rowow's published Staged Disclosure Policy and General Safety Framework [4] gate step-by-step hazardous releases behind published safety modules. Scoping work turns these founder policies into community-governed gates with a documented review process, so growth in contributors does not outrun safety documentation.

Deliverable: a written risk analysis and security plan, with the QC program design and BOM provenance standard specified to pilot readiness.

4.4 Community building

The external content developers are flow-battery builders (cell and stack designs, cycling data), water-treatment users (application notes, fouling data), metal-recovery practitioners (durability data in

aggressive chemistries), and educators (lab curricula and teaching modules). For each, the plan defines a contribution unit that is small, valuable, and recognized: a build report, a data row, an application note, a lesson plan.

The award year includes two community workshops (one virtual; one in person, co-located with a domestic conference) and a membrane build-and-test event structured around the draft QC protocol: participants fabricate membranes in their own workspaces beforehand using mailed precursor kits and the published guides, then convene for a testing day at the workshop venue where all membranes are measured side by side under the draft protocol, with remote participants testing on camera. Every membrane tested becomes a build report and characterization data, and the event doubles as validation data for the QC protocol and as maintainer recruitment. A community advisory group of at least five external members will be recruited from the independent replicators, active chat-server contributors, and academic users, seeding the governance body designed in 4.2. Userbase growth continues through the proven channel: independent maker-channel replications have organically reached audiences in the hundreds of thousands [6], and the plan formalizes replication support (materials lists, office hours, verification) so each new public replication becomes a recruitment event. Deliverable: a community growth plan with named candidate maintainers and advisory-group members, and measured baseline-to-endline community metrics.

5. Team qualification

Robert Karas (PI, Technical Lead) is the inventor named on US patent application No. 19/531,984 covering the membrane and its manufacturing process. He has worked full time on the technology since November 2023, built and operates Rowow's 1,400-square-foot electrochemistry laboratory in Florida, designed and fabricated the firm's electrolysis cells, membrane production line, and test apparatus, and performs the firm's analytical work on a Rigaku NEX DE XRF spectrometer. He authored the product's public documentation, build guides, and the governance corpus (Open Technology Charter, Staged Disclosure Policy, Patent Non-Assertion Pledge) that this award converts into community structures, and he built the existing community: the repository and its contribution infrastructure, the video build guides, and the community chat server. The qualification argument is direct: the PI created the product, released it under a strongly reciprocal license, attracted independent replicators and verifiers without any funded outreach, and has already published the governance thinking that Track 1 scoping formalizes.

section shortened

Rowow LLC is a US-based for-profit small business, a Florida LLC wholly owned by Robert Karas, a US citizen. The firm meets the solicitation's ownership and control requirements: 100 percent of equity is directly owned and controlled by a US citizen, with no foreign ownership, control, or affiliation. The PI is an employee of the proposing organization, normally resident in the United States. All PESOSE-funded personnel will have the legal right to work in the US for Rowow LLC.

6. Milestones and evaluation plan

Twelve-month award period, quarterly milestones, each with a named artifact:

- Q1: I-Corps for PESOSE team registered and Executive Summary submitted; interview instrument designed; community baseline metrics captured (stars, forks, contributors, chat activity, verified builds); advisory-group candidate list drafted.
- Q2: I-Corps participation underway or complete with at least 50 interviews done; first (virtual) workshop held; QC test protocol draft published for community comment; BOM provenance field set drafted.
- Q3: 100 interviews complete; ecosystem-discovery report delivered; governance structure recommendation with draft formation documents; round-robin pilot design complete with named participating laboratories; repository security controls implemented.
- Q4: in-person workshop and build-and-test event held; risk analysis and security plan delivered; community growth plan with named maintainer candidates; sustainability model (managing organization budget, revenue and funding mix, Rowow's arms-length role); Track 2 proposal package assembled.

Evaluation tracks quantitative indicators baseline to endline: interview count (target 100), workshop and event attendance, first-time contributors (target at least 10 during the award year), verified replications (baseline 2), characterization data rows, and advisory-group formation (target at least 5 external members seated). The evaluation plan itself is a deliverable input to the Track 2 baseline.

Broader Impacts

Domestic capability: low-cost membranes are an enabling input for domestic critical-minerals recovery and refining, an explicit national priority; an OSE ensures any qualified domestic fabricator can produce the component without royalty or single-vendor lock-in. Accessibility: sub-dollar membranes put electrodialysis, flow batteries, and electrochemical water treatment within reach of small laboratories, community colleges, and startups that cannot pay hundreds of dollars per square foot. Note, November 2026: claim as submitted in August 2026. Not a verified current result. Education and workforce: educator-contributed curricula, the workshops, and the build-and-test event train hands-on electrochemistry and measurement skills. Safety: the staged-disclosure and certification framework raises the safety floor for a public that is already building electrochemical hardware from open designs, whether or not anyone governs it. The project directly supports PESOSE measures of success: new research infrastructure (the QC and certification program), expanded data sets (the community characterization database), and STEM workforce development.

Relationship to other pending federal support

This proposal funds ecosystem formation only: governance, community, quality-control program design, security and provenance planning, and sustainability scoping. It funds no membrane, cell, or process research and development. Rowow LLC has a pending NSF SBIR Phase I full proposal covering membrane-based electrowinning product R&D for a specific application, a pending DOE NETL application, and a submitted DLA SBIR Phase I proposal; all are product and process R&D with zero scientific or budgetary overlap with this ecosystem-formation effort, and all appear on the PI's Current and Pending (Other) Support. If any is awarded, Rowow will notify the cognizant program officials; no agency has funded any portion of the work proposed here.

Footnote added November 2026, not part of the submitted text, on "verified replications (baseline 2)" in section 6: (Note, November 2026: baseline as submitted in August 2026; at least four builders outside Rowow LLC have since documented making and using the membrane, a minimum, not the total.)

References Cited

Note, November 2026: as submitted, the citation numbers used in the Project Description from [6 onward do not match this list one to one. The list is reproduced as submitted.]

1. Rowow LLC. "Open-sourced off-the-shelf ion exchange membrane." Public repository, initial release February 6, 2026. https://github.com/Rowow-LLC/Open-sourced-off-the-shelf-ion-exchange-membrane (license: CERN-OHL-S v2 for design source; CC BY-SA 4.0 for documentation). Accessed August 2026.
2. Rowow LLC. "Membrane build guide video series." YouTube channel @Rowow. https://www.youtube.com/@Rowow. Accessed August 2026.
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4. Rowow LLC. "Rowow Open Technology Charter v1.0," "Staged Disclosure Policy v1.0," "Patent Non-Assertion Pledge v1.0," and "General Safety Framework v1.0." June 17, 2026. Published as public drafts for comment; not yet adopted. https://rowow.net (patents status page: https://rowow.net/patents). Accessed August 2026.
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6. Cybersecurity and Infrastructure Security Agency (CISA) and National Security Agency (NSA). "Securing the Software Supply Chain: Recommended Practices Guide for Developers." September 2022.
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8. United States Patent and Trademark Office. US non-provisional patent application No. 19/531,984, "Low-Cost Homogeneous Ion Exchange Membrane Formed from Off-the-Shelf Precursors and Manufacturing Process Thereof," filed February 6, 2026, inventor Robert Karas.